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Date of Deposit: November 27, 2001

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FIBER OPTIC TRANSCEIVER ARRAY FOR IMPLEMENTING TESTING

Related Applications

Related United States patent applications by Randolph B. Heineke and David John Orser assigned to the present assignee are being filed on the same day as the present patent application and including:

United States patent application Serial Number ______________, entitled "FIBER OPTIC TRANSCEIVER ARRAY AND FIBER OPTIC TRANSCEIVER CHANNEL FOR SHORT WAVE FIBER OPTIC COMMUNICATIONS"; and

United States patent application Serial Number ______________, entitled "DETECTOR FOR SHORT WAVE FIBER OPTIC COMMUNICATIONS WITH COMPENSATION TO REDUCE DETECTOR JITTER".

Field of the Invention

The present invention relates generally to the data communications field, and more particularly, relates to a fiber optic transceiver array for implementing testing.

Description of the Related Art

Demand for bandwidth in data communications appears to be generally unlimited. One of the economic considerations to meet this

demand is to minimize the physical size of fiber optic transceiver channels. One known arrangement uses an array of integrated photodetector and preamplifiers to reduce the number of components and connections in the fiber optic transceiver channels and gain benefits of compactness.

Multiple fiber optic transceiver channels can be integrated together on an integrated circuit chip. Testing is important for chips with large array sizes and particularly with the attendant yields of larger array sizes, while the difficulty of testing such chips tends to significantly increase.

There is a need for fiber optic transceiver arrays that are compact and minimize the number of components and connections, providing effective and reliable signal integrity and that allow effective testing of multiple fiber optic transceiver channels. As used in the following description and claims, the terms fiber optic transceiver and fiber optic transceiver channel should be understood to include a fiber optic receiver receiving a light beam input and a transmitter providing a voltage output.

Summary of the Invention

A principal object of the present invention is to provide a fiber optic transceiver array for implementing testing. Other important objects of the present invention are to provide such a fiber optic transceiver array for implementing testing substantially without negative effect and that overcome many of the disadvantages of prior art arrangements.

In brief, a fiber optic transceiver array is provided for implementing testing. A fiber optic transceiver array of the invention includes a plurality of sequential fiber optic transceiver channels. Each fiber optic transceiver channel includes a photodetector and has a predefined channel width. The photodetector of each sequential fiber optic transceiver channel is spaced apart substantially equal to the predefined channel width. A plurality of test pads is included in each fiber optic transceiver channel. A pair of power pads is included in each fiber optic transceiver channel.

In accordance with features of the invention, the predefined channel width and spacing between adjacent photodetectors is substantially equal to

a spacing between fibers in a standard fiber optic cable. The plurality of test pads of each fiber optic transceiver channel includes a predefined sequence including a ground and a pair of differential channel outputs.

Brief Description of the Drawings

The present invention together with the above and other objects and advantages may best be understood from the following detailed description of the preferred embodiments of the invention illustrated in the drawings, wherein:

FIG. 1 is a schematic elevational view illustrating an array of fiber optic transceiver channels in accordance with the preferred embodiment;

FIG. 2 illustrates serial testing of the array of fiber optic transceiver channels of FIG. 1 in accordance with the preferred embodiment; and

FIG. 3 illustrates an exemplary tester for serial testing of fiber optic transceiver channels of FIG. 1 in accordance with the preferred embodiment.

Detailed Description of the Preferred Embodiments

Having reference now to the drawings, in FIG. 1, there is shown an array of fiber optic transceivers generally designated by the reference character 100 in accordance with the preferred embodiment. Fiber optic transceiver array 100 includes a plurality of fiber optic transceiver detectors or fiber optic transceiver channels 102, with one channel 102 indicated in dotted line. In accordance with the preferred embodiment serial testing is implemented for sequential fiber optic transceiver channels 102 in the fiber optic transceiver array 100. One photodetector 104 is included in each of multiple fiber optic transceiver channels 102. As shown in FIG. 1, fiber optic transceiver array 100 includes a series of twelve fiber optic transceiver channels 102, each having an associated one of twelve photodetectors 104. The input to each photodetector 104 is a modulated light beam.

As shown in FIG. 1, fiber optic transceiver array 100 includes a plurality of bottom bond pads 106, a plurality of top power probe pads 108,

and a plurality of test probe pads 110 located above the bottom bond pads 106, with three test probe pads 110 included within each channel 102. Power for testing is supplied into the fiber optic transceiver channels 102 of fiber optic transceiver array 100 through the top power probe pads 108.

Fiber optic transceiver array 100 includes a large over-chip, power distribution bypass capacitor 112. Fiber optic transceiver array 100 includes a power source Vdd bus bar 114 that distributes a power source Vdd around the perimeter of the array 100 through the large over-chip, power distribution bypass capacitor 112. Grounds are distributed around the perimeter of the array 100 in a similar manner through bypass capacitor 112. Bypass capacitor 112 minimizes the impedance between ground and power source Vdd.

Power probe pads 108 include alternating ground and power source Vdd pads 120 and 122. One ground pad 120 and power source Vdd pad 122 is included in each fiber optic transceiver channel 102. As shown in FIG. 1, an extra pair of ground and power source Vdd pads 120 and 122 are provided at each end of the series of power probe pads 108. The extra pairs of ground and power source Vdd pads 120 and 122 provide multiple power probe pads 108 for testing the end channels 102 in accordance with the preferred embodiment.

Power noise sensitivity between neighboring fiber optic transceiver channels is provided by a threaded ground connection 124 and a threaded power source Vdd connection 126 respectively provided for alternate fiber optic transceiver channels. Threaded ground test probe pads 110 of alternates ones of the fiber optic transceiver channels 102 are connected to the bottom ground pads 106. Alternate other ones of fiber optic transceiver channels 102 include the threaded power source Vdd connection 126 threaded between the GND and differential output OUT pads 106.

In accordance with features of the preferred embodiment, effective and reliable testing is achieved for fiber optic transceiver array 100 including the parallel fiber optic transceiver channels 102 of the preferred embodiment. Each elongate channel 102 has a predefined width indicated by an arrow A. The photodetectors 104 are uniformly spaced apart

substantially equal to the width of channel 102 also indicated by an arrow labeled A. The width A of channel 102 and spacing between photodetectors 104 advantageously is substantially equal to a predefined spacing between fibers in a standard parallel fiber optic cable, for example, at 250 μm.

In accordance with features of the preferred embodiment, three test probe pads 110 are provided per channel width A or per 250 μm within each channel 102 in accordance with the preferred embodiment. One pair of ground and power source Vdd pads 120 and 122 is provided per channel width A or 250 μm within each channel 102 in accordance with the preferred embodiment.

As shown in FIG. 1, each sequential fiber optic transceiver channel 102 in array 100 includes three test probe pads 110 providing connections to ground and differential channel outputs respectively labeled GND, OUT, and OUTC. Bottom bond pads 106 include alternate connections to ground labeled GND and power source labeled Vdd spaced apart by respective connections to differential outputs labeled OUT, and OUTC. Fiber optic transceiver array 100 includes twenty-eight power probe pads 108 and thirty-seven test probe pads 110. An extra ground pad GND, 110 is provided at each end of the series of test probe pads 110 for testing the last channel 102 in array 100 in accordance with the preferred embodiment.

Three probe pads GND, OUT, and OUTC 110 of the preferred embodiment was determined to be much more desirable than four probe pads per channel. Three probe pads GND, OUT, and OUTC, 110 provide more leeway for testing the channels 102 with conventional types of testers or standard wafer testers. While four pads per channel would allow each differential signal to have its own return line for more accurate probing, allowing every other lead to be a ground, this would forego the benefit of the close spacing of the differential channel outputs OUT and OUTC while maintaining possible electromagnetic contamination paths arising from asymmetric grounding.

In accordance with features of the preferred embodiment, the ground probe pad GND, 110 is positioned on the opposite side of the differential channel outputs OUT and OUTC from a next sequential channel 102 in the

fiber optic transceiver array 100. The ordering of probe pads 110 as GND, OUT, and OUTC within each channel 102 enables sequential testing of the channels 102 with the ground probe pad GND, 110 of a next channel 102 serving as a return line for a current channel under test. The ordering of probe pads 110 as GND, OUT, and OUTC within each channel 102 also minimizes the spacing between the differential channel outputs OUT and OUTC, reducing the emissions. The GND, OUT, and OUTC ordering of probe pads 110 within each channel 102 also assures that there is a ground between the differential channel outputs OUT and OUTC of each channel 102 to increase isolation between channels.

In accordance with features of the preferred embodiment, serial testing of fiber optic transceiver array 100 is performed. Tester signal and power probes and beam are placed on the first channel 102-1 and stepped by the channel spacing A equal to the standard fiber spacing to test each sequential channel until the last channel 102-12 in the array 100 is tested. Fiber optic transceiver array 100 allows testing to be implemented with an economical tester, avoiding the expense and complexity of designing a tester with the capability to test all channels simultaneously.

Referring also FIGS. 2 and 3, serial testing of the multiple fiber optic transceivers 102 of the fiber optic transceiver array 100 and an exemplary tester 300 in accordance with the preferred embodiment are illustrated. A standard type of wafer tester 300 includes a plurality of power probes 302 for supplying power to array power pads 108, a plurality of signal probes 304 for probing array test pads 110, and a light source 306 for projecting a light beam onto a photodetector 104. For example, tester 300 includes six power probes 302 for probing three adjacent pairs of ground and power source Vdd pads 120 and 122 of the power test pads 108 and four signal probes for probing four adjacent test probe pads 110 including GND, OUT, and OUTC of a channel 102 and GND or a next sequential channel 102. Tester 300 projects a beam onto the photodetector 104 with the power and signal probes 302 and 304 aligned with the pads.

Multiple power probe pads 108 are used to provide the required current to power all channels 102 in the array 100 simultaneously during testing. Separate power for each channel 102 in the array 100 is not used

because this would require more wiring capacity and also reduce the amount of power supplies decoupling per channel that could be obtained. Power for testing is supplied, for example, using the two power probe pads GND and Vdd, 120 and 122 of the channel under test together with the two probe pads GND and Vdd, 120 and 122 of the adjacent channels.

Referring to FIG. 2, serial testing of channels 102-1 through 102-12 is performed. The first channel 102-1 is tested first. A beam is projected onto photodetector 104-1 with power applied to the first three adjacent pairs of ground and power source Vdd pads 120 and 122 of the power test pads 108 and signal probing of the first four adjacent test probe pads 110 including GND, OUT, and OUTC of channel 102-1 and GND of the next sequential channel 102-2. Next the power and signal probes and beam are stepped by the predefined channel width spacing and channel 102-2 is tested. A beam is projected onto photodetector 104-2 with power applied to the three adjacent pairs of ground and power source Vdd pads 120 and 122 of the power test pads 108 and signal probing of the four adjacent test probe pads 110 including GND, OUT, and OUTC of channel 102-2 and GND of the next sequential channel 102-3. Then tester signal and power probes and beam are stepped by the channel spacing A equal to the standard fiber spacing for testing the next sequential channel 102-3 and each sequential channel though the last channel 102-12 in the array 100 is tested.

Except for the first channel 102-1, the ground pad GND, 110 is probed twice. The first pad probed is the ground pad GND, 110 of a current channel under test and the fourth pad probed is the ground pad GND, 110 of the next sequential channel. The second and third pads probed for each channel tested are the differential channel outputs OUT and OUTC for the current channel under test. The last ground pad GND in the test probe pads 110 is used for testing the last channel 102-12, providing a fourth test probe pad for that channel.

While the present invention has been described with reference to the details of the embodiments of the invention shown in the drawing, these details are not intended to limit the scope of the invention as claimed in the appended claims.